REMARKS

Reconsideration and allowance in view of the foregoing amendments and the following remarks are respectfully requested. By this Amendment, claims 1, 4, 5, 8 and 12 have been amended to clarify the recited invention. Claims 13-23 have been added to provide additional protection for the invention. No new matter has been added as the claims are fully supported by the originally filed application. Upon entry of this Amendment, claims 1-23 are pending in the application.

The Office Action rejected claims 1-12 under 35 U.S.C. § 112, first paragraph, as containing subject matter which was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventor(s), at the time the application was filed, had possession of the claimed invention. Applicants have amended independent claims 1 and 12 to reflect the fact that the valve body is located on a side of said small aperture away from said vaporizing chamber so as to open and close an inlet port of said small aperture, said inlet port being located toward the liquid storing chamber (See, amended claims 1 and 12). Accordingly, Applicants submit the objection is overcome. Reconsideration and withdrawal of the rejection are requested.

The Office Action rejected claims 1-5 and 8-12 under 35 U.S.C. § 102(b) as being anticipated by U.S. Patent No. 5,440,887, issued to Nishizato et al. ("Nishizato"). The Office Action also rejected claims 1-6, 8-9 and 11-12 under 35 U.S.C. § 102(e) as being anticipated by U.S. Patent No. 6,224,681, issued to Sivaramakrishnan et al. ("Sivaramakrishnan"). Applicants traverse the rejections because Nishizato and Sivaramakrishnan fail to teach or suggest all the features recited in the rejected claims. In particular, neither Nishizato nor Sivaramakrishnan teach or suggest a vaporizer and semiconductor manufacturing system in which a valve body is located on a side of said small aperture away from said vaporizing chamber so as to open and close an inlet port of the small aperture, said inlet port being

located toward the liquid storing chamber, as recited in amended independent claims 1 and 12.

The claims of the present application require that the small aperture extend from liquid storing chamber to the vaporizing chamber. In Nishizato, element 12 is a vaporization valve, while element 13 is the vaporization chamber. In order to meet the requirements of claims 1 and 12, the valve body 7A of Nishizato would have to open and close an inlet port of the small aperture 23b and the inlet port would have to be located towards the liquid storing chamber 23. Applicants submit that Nishizato fails to meet these requirements.

In Nishizato, flow rate control valve 7 does not open/close an inlet port of small aperture; in fact it opens/closes an end of the liquid storing chamber 23 that is opposite the small aperture. Applicants note that vaporization valve 12 does open/close the small aperture; however, vaporization valve 12 open/closes the small aperture from the outlet side rather than the inlet port, as recited in claims 1 and 12. Furthermore, the vaporization valve 12 is located in the vaporization chamber 13 – contrary to what is required of the valve body in amended claims 1 and 12 of the present application.

Since Nishizato fails to teach or suggest a vaporizer or semiconductor manufacturing system having each of the features recited in amended claims 1 and 12, claims 1 and 12 are not anticipated.

With respect to Sivaramakrishnan, valve bore 44 and piston 46 control the flow of liquid to liquid storing chamber 48 and through opening/aperture 49 to the vaporizing area 51. As such, valve body 46 opens/closes and inlet of the liquid storing chamber. Thus, Applicants submit that Sivaramakrishnan fails to teach or suggest a vaporizer or semiconductor manufacturing system that includes "a valve body located on a side of the small aperture away from said vaporizing chamber so as to open and close an inlet port of

said small aperture, said inlet port being located towards the liquid storing chamber," as recited in amended claims 1 and 12.

Since Sivaramakrishnan fails to teach or suggest a vaporizer or semiconductor manufacturing system having all of the features recited in amended claims 1 and 12, claims 1 and 12 are not anticipated.

Claims 2-11 depend from independent claim 1. Applicants have discussed above how amended claim 1 is patentable over Nishizato and Sivaramakrishnan. By virtue of their dependence from claim 1, dependent claims 2-11 also contain the allowable subject matter of claim 1, and thus are patentable over Nishizato and Sivaramakrishnan. Reconsideration and withdrawal of the rejections are requested.

The Office Action rejected claim 7 under 35 U.S.C. § 103(a) as being unpatentable over Nishizato in view of U.S. Patent 5,630,878, issued to Yuuki et al ("Yuuki"). Applicants traverse the rejection because neither Nishizato nor Yuuki, analyzed alone or in combination, teach or suggest each of the features recited in the claims of the present invention. In particular, the applied combination of Nishizato and Yuuki fails to teach a vaporizer, including among other features, a valve body located on a side of said small aperture away from said vaporizing chamber so as to open and close an inlet port of said small aperture, said inlet port being located towards the liquid storing chamber, as recited in claim 1.

Yuuki merely discloses a method and apparatus for depositing various kinds of thin films on a substrate by means of Chemical Vapor Deposition (CVD). In Yuuki, the vaporizing chamber does not include a valve which opens/closes or controls the opening of a small aperture through which a liquid material flows. In fact, Applicants respectfully note that the liquid CVD material and carrier gas are fed to the vaporizer 4 through the material feeding pipe (Col. 13, lines 1-6). Thus, Yuuki fails to teach a "valve body located on a side of said small aperture away from said vaporizing chamber so as to open and close an inlet

port of said small aperture, said inlet port being located towards the liquid storing chamber" as recited in claim 1 of the present invention.

Since Yuuki fails to teach or suggest each of the features recited in claim 1, it also fails to remedy all the deficiencies of Nishizato. As a result, even if Yuuki and Nishizato were combined as suggested by the Office Action, the proposed combination would fail to provide a vaporizer including all the features recited in claim 1.

Claim 7 depends from independent claim 1. Applicants have discussed above the patentable features of claim 1. By virtue of its dependence from claim 1, dependent claim 7 also contains this patentable subject matter. Reconsideration and withdrawal of the rejection of claim 7 are requested.

All rejections having been addressed, it is respectfully submitted that the present application is in condition for allowance and a notice to that effect is earnestly solicited.

Attached hereto as an Appendix captioned "**Version with markings to show changes made**" is a marked-up version of the changes made to the claims by the current amendment.

Respectfully submitted,

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Attachment: Appendix (pgs. 17-24)

APPENDIX

VERSION WITH MARKINGS TO SHOW CHANGES MADE

IN THE SPECIFICATION:

The specification is changed as follows:

Change the paragraph bridging pages 2 and 3 as follows:

A linear actuator 18 is provided to the valve body 4 on the opposite side of the vaporizing chamber [8] 10 with respect to the diaphragm 8. The linear actuator 18 includes a drive shaft 20 that protrudes into the valve chamber 6. The drive shaft 20 presses the diaphragm 8 so as to open and close the valve port 12 in a manner in which a degree of opening of the valve port 12 can be controlled. The entire vaporizer 2 is heated to a predetermined temperature by a heater (not shown in the figure) so as to promote vaporization of the liquid material by heating and prevent the material gas (vaporized liquid material) from being liquefied.

Change the paragraph bridging pages 3 and 4 as follows:

Accordingly, in the vaporizing chamber 10, the vaporization of the liquid material cannot be sufficiently performed, and atomized liquid material (mist of the liquid material) may adhere to an inner wall of the vaporizing chamber 10. Most of the atomized liquid material adhering to the inner wall of the vaporizing chamber 10 is gradually vaporized since the entire vaporizer 2 is heated to a predetermined temperature. However, in many cases the liquid material is a chemically unstable material, and the liquid material may [decomposed] decompose due to the heat reaction before being vaporized. Thus, there is a problem [in that] of a metal component being [deposit] deposited on the inner wall of the vaporizing chamber

10, which closes the openings provided in the inner wall of the vaporizing chamber 10.

Change the paragraph bridging pages 4 and 5 as follows:

In order to achieve the above-mentioned objects, there is provided according to one aspect of the present invention a vaporizer which vaporizes a liquid material under a depressurized atmosphere, the vaporizer comprising: a liquid storing chamber temporarily storing the liquid material therein; a vaporizing chamber set in the depressurized atmosphere; a small aperture connecting between the liquid storing chamber and the vaporizing chamber so as to supply the liquid material to the vaporizing chamber; a valve body which opens and closes an inlet port of the small aperture that opens the liquid storing chamber; and an actuator controlling a degree of opening of the valve body.

Change the paragraph beginning on page 5, line 5 as follows:

According to the above-mentioned invention, the liquid material temporarily stored in the liquid storing chamber is supplied to the vaporizing chamber by passing through the small aperture when the valve body is moved by the actuator so as to open the inlet port of the small aperture. The vaporizing chamber is configured to define a larger space than that of the conventional vaporizer. Thus, the liquid material discharged from the outlet port of the small aperture can be efficiently atomized without adhering to the wall of the vaporizing chamber, and, thereby, the liquid material entering the vaporizing chamber can be rapidly and efficiently vaporized.

Change the paragraph beginning on page 8, line 22 as follows:

A description will now be [give] given, with reference to FIGS. 2 through 6, of a first embodiment of the present invention. FIG. 2 is a structural diagram of a semiconductor

manufacturing system using a vaporizer according to the first embodiment of the present invention. FIG. 3 is a cross-sectional view of the vaporizer shown in FIG. 2. FIGS. 4, 5 and 6 are enlarged cross-sectional view of a part of the vaporizer shown in FIG. 3. FIG. 7 is a plan view of a diaphragm shown in FIG. 3. In the present embodiment, a description will be given of a case in which a copper (Cu) film is deposited by using Cu(hfac)TMVS according to the CVD method.

Change the paragraph beginning on page 10, line 2 as follows:

A heater 44 such as a tape heater is wound on the material gas passage [44] 40 on the downstream side of the vaporizer 26 so as to maintain the material gas passage 40 at a temperature ranging from, for example, 50 to 70 C, which temperature is higher than the liquidizing temperature of the film deposition gas and lower than the decomposition temperature.

Change the paragraph bridging pages 10 and 11 as follows:

Additionally, a showerhead 56 is mounted on a top of the process chamber 48 so that the showerhead 56 is opposite to the table 52 and covers the entire top surface of the table 52. An end of the material gas [supply] passage 40 is connected to an inlet port of the showerhead 56 so that the film deposition gas can be showered inside the process chamber 48. A load lock chamber 60 is connected to an inner wall of the process chamber 48, which load lock chamber 60 can be set under a vacuum through a gate valve 58.

Change the paragraph beginning on page 12, line 3 as follows:

The small aperture 66, which is connected to the vaporizing chamber 64, is provided on the left side of the valve body [74A] in the figure. A shallow recess 78 is provided in the

vicinity of the small aperture 66. A support member 80 is attached to the vaporizer body 74 so as to cover the entire recess 78. A shallow recess 82 corresponding to the shallow recess 78 is provided to the support member 80. A disk-like diaphragm 84 is provided as a valve body 70 between the support member 80 and the vaporizer body 74 so that the diaphragm 84 sealingly separates the recess 82 of the support member 80 and the recess 78 of the vaporizer body 74 from each other. The diaphragm 84 as the valve body 70 is made of a thin stainless steel disc plate as shown in FIG. 7, and is configured to [be able to bent] bend or [deformed] deform in a direction of a thickness of the diaphragm 84 (refer to FIG. 6). The recess 78 sealed by the diaphragm 84 serves as the liquid storing chamber 62. A liquid passage 90 having a diameter of about 3 mm is formed in the vaporizer body 74 so as to connect the recess 78 to the liquid material supply passage 38.

Change the paragraph bridging pages 14 and 15 as follows:

A brief description will now be given of dimensions of major parts. The diameter D1 of the outlet port 64A of the vaporizing chamber 64 ranges from about 12 mm to about 20 mm. The diameter D2 of the small aperture 66 ranges from about 0.5 mm to 2 mm, and the length L1 of the small aperture 66 is less than about 5 mm (refer to FIG. 4). In order to reduce the amount of the liquid material 30 stored in the small aperture 66, the diameter D2 and the length L1 are preferably set as small as possible so as to control the volume of the small aperture 66 within an amount of liquid material 30 corresponding to several minutes of flow. Additionally, the length L2 of the vaporizing chamber 64 is set to a value ranging [form] from about 12 mm to about 20 mm so that a pressure loss generated by the vaporizing chamber 64 is reduced as much as possible in comparison with the diameter D1 of the outlet port 64A.

Change the paragraph bridging pages 15 and 16 as follows:

The liquid material 30 such as Cu(hfac)TMVS stored in the material tank 32 of the material supply system 28 is maintained at a room temperature so as to prevent from being decomposed. The liquid material 30 is delivered through the liquid material supply passage [30] 38 by being pressurized by a pressurizing gas such as He gas supplied from the pressurizing pipe 36, and is introduced into the vaporizer 26 after the flow amount thereof is detected by the mass-flow meter 42 provided in the middle of the liquid material supply passage 38. A liquid flow signal generated by the mass-flow meter 42 is fed back to the valve body so as to control the flow of the liquid material 30. The liquid material 30 introduced into the vaporizer 26 is turned to a material gas by being vaporized as described later by being subjected to an adiabatic expansion in the vaporizer 26. The material gas flows through the material gas passage 40, which is heated to be a temperature higher than the meniscus point and lower than the decomposition reaction point, and is introduced into the process chamber 48 through the showerhead 56 of the process apparatus 24. The material gas is used to deposit a Cu film on the wafer W in the process chamber.

Change the paragraph bridging pages 16 and 17 as follows:

A description will now be given, with reference to FIGS. 3 to 6, of an operation of the vaporizer 26. FIG. 4 shows a [stated] state in which the valve [off] of the vaporizer 26 is full-opened. FIG. 5 shows a state in which the valve of the vaporizer 26 is half-opened. FIG. 6 shows a state in which the valve of the vaporizer 26 is completely closed. In FIG. 3, the liquid material 30 flowing through the liquid material supply passage 38 enters via the liquid passage 90 the liquid storing chamber 62, which is defined by the diaphragm 84 and has a small volume. The liquid material 30 enters the inlet port 68 and passes through the small aperture 66 when the diaphragm serving as a valve body does not seat on the inlet port 68 of

the small aperture 66 and is separated from the inlet port 68, as shown in FIGS. 4 and 5. The liquid material 30 is then discharged from the outlet port 104 on the opposite end toward the vaporizing chamber 64, which is maintained at a negative pressure. Immediately after the discharge, the liquid material 30 is atomized so as to be fine mists, and is simultaneously vaporized, which results in generation of the material gas. At the same time, He gas as a carrier gas is injected from the gas injection port 102 of the carrier gas passage 100. Since the volume of the vaporizing chamber 64 is very large unlike the conventional vaporizer, the liquid material 30 can be vaporized very efficiently. Accordingly, the fine mists [so] do not adhere to the inner wall of the vaporizing chamber 64, and the liquid material does not remain in the vaporizing chamber 64. Additionally, since the liquid material 30 can be efficiently vaporized, the liquid material does not decompose due to heat in the vaporizing chamber 64, thereby preventing the vaporizer itself from being closed by the deposited material produced by decomposition. As mentioned above, since the supplied liquid material can be used for deposition after being completely vaporized, a film having a designed thickness can be deposited.

IN THE CLAIMS:

Please amend claims 1, 4, 5, 8 and 12 as follows:

1. (Twice Amended) A vaporizer which vaporizes a liquid material under a depressurized atmosphere, the vaporizer comprising:

a liquid storing chamber temporarily storing the liquid material therein;

a vaporizing chamber set in the depressurized atmosphere;

a small aperture connecting between the liquid storing chamber and the vaporizing chamber so as to supply the liquid material to the vaporizing chamber;

a valve body located [in] on a side of said small aperture away from said vaporizing chamber [the liquid storing chamber] so as to open and close an inlet port of said small aperture, said inlet port being located toward the liquid storing chamber [on a side of the liquid storing chamber]; and

an actuator controlling a degree of opening of the valve body[.],

wherein said valve body is located outside of said vaporizing chamber to permit an uninhibited flow of the liquid material, thereby achieving a smooth flow of vapor of the liquid material.

4. (Amended) The vaporizer as claimed in claim 3, wherein the carrier gas introducing means includes an injecting port positioned in the vicinity of the outlet port of the small aperture so as to inject the carrier gas from a surrounding area of the outlet port in a direction substantially perpendicular to a direction of [discharge of the liquid material from the small aperture] a flow of the liquid material from said inlet port to said outlet port of said small aperture.

5. (Amended) The vaporizer as claimed in claim 3, wherein the carrier gas introducing means includes an injecting port positioned in the vicinity of the outlet port of the small aperture so as to inject the carrier gas in a direction substantially opposite to a direction of [discharge of the liquid material from the small aperture] a flow of the liquid material from said inlet port to said outlet port of said small aperture.

8. (Twice Amended) The vaporizer as claimed in claim 1, wherein a direction of [discharge of the liquid material from an outlet port of the small aperture] a flow of the liquid material from said inlet port to said outlet port of said small aperture coincides with a

direction of an exit of the vaporizing chamber.

12. (Amended) A semiconductor manufacturing system comprising:

a process apparatus performing a process using a vaporized material; and

a vaporizer which vaporizes a liquid material under a depressurized atmosphere so as to generate the vaporized material, the vaporizer comprising:

a liquid storing chamber temporarily storing the liquid material therein;

a vaporizing chamber set in a depressurized atmosphere;

a small aperture connecting between the liquid storing chamber and the vaporizing chamber so as to supply the liquid material to the vaporizing chamber;

a valve body [which opens and closes] <u>located on a side of said small aperture away from said vaporizing chamber so as to open and close</u> an inlet port of <u>said small aperture, said inlet port being located toward</u> the liquid storing chamber; and

an actuator controlling a degree of opening of the valve body[.],

<u>wherein said valve body is located outside of said vaporizing chamber to permit an uninhibited flow of the liquid material, thereby achieving a smooth flow of vapor of the liquid material.</u>

End of Appendix